

## EVALUATION OF ROAD TRACK SURVEYS FOR COUGARS (*FELIS CONCOLOR*)

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**ABSTRACT**—Road track surveys were a poor index of cougar density in southern Utah. The weak relationship we found between track-finding frequency and cougar density undoubtedly resulted in part from the fact that available roads do not sample properly from the nonuniformly distributed cougar population. However, the significantly positive relationship ( $r^2 = .73$ ) we found between track-finding frequency and number of cougar home ranges crossing the survey road suggested the technique may be of use in monitoring cougar populations where road abundance and location allow the population to be sampled properly. The amount of variance in track-finding frequency unexplained by number of home ranges overlapping survey roads indicates the index may be useful in demonstrating only relatively large changes in cougar population size.

*Key words:* cougar, *Felis concolor*, track survey, Utah.

Sign left by animals has been commonly used by wildlife managers to make inferences about population characteristics (Neff 1968, Lindzey et al. 1977, Novak 1977). This approach is appealing because it seldom requires specialized equipment and is usually much less costly than other, more intensive techniques. The approach requires, however, that the relationship between sign and the population characteristic of interest (e.g., size, composition) be understood.

Track counts have been used to indicate cougar (*Felis concolor*) abundance or change in abundance, but population estimates were seldom available to evaluate the validity of these indices (Koford 1975, Shaw 1979, Fitzhugh and Smallwood 1985). Van Dyke et al. (1986), however, conducted road track surveys in an area of known cougar density and found a weak relationship ( $r^2 = .18$ ) between track-finding frequency and density. Because of the potential value of this technique to agencies charged with management of cougars, our objective was to test again the relationship between track-finding frequency and cougar density following procedures of Van Dyke et al. (1986). Additionally, we examined the influence cougar distribution patterns, as measured by cougar home ranges, had on track-finding frequency.

### STUDY AREA

The Boulder-Escalante study area comprises 4500 km<sup>2</sup> of Garfield and Kane counties in south central Utah. Boulder, Escalante, and Canaan mountains dominate the area topographically, and elevation ranges from 1350 m to 3355 m. Hot, dry weather is characteristic of June and July, with rains beginning in August and continuing through September. Annual precipitation ranges from 18 cm at low elevations to 60 cm at high elevations; average temperatures for Escalante in January and July are -2.5 C and 24.5 C, respectively (U.S. Department of Commerce 1979).

Desert grass and shrub communities dominate the vegetation with a sparse overstory of pinyon pine (*Pinus edulis*) and juniper (*Juniperus osteosperma*) between 1350 m and 1800 m. Dense pinyon-juniper stands with a sagebrush (*Artemisia tridentata*) understorey dominate the vegetation between 1800 m and 2400 m. Ponderosa pine (*Pinus ponderosa*) and oakbrush (*Quercus gambelii*) are prominent above 2400 m where rocky, vertical-walled canyons with large areas of bare sandstone characterize the topography. Subalpine meadows with small stands of Engelmann spruce (*Picea engelmannii*), quaking aspen (*Populus tremuloides*),

and white fir (*Abies concolor*) occur above 2700 m. River canyons transverse the area with associated vegetation consisting primarily of Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spp.) (Ackerman 1982, Hemker 1982).

The human population of about 800 is concentrated in the towns of Escalante and Boulder. Livestock grazing, timber harvesting, and energy exploration are the primary land uses in the area. Road density is about 25 km of road per 100 km<sup>2</sup> (Van Dyke et al. 1986). Hunting of cougars is prohibited on the study area.

## METHODS

### Capture and Monitoring Procedures

Cougars were tracked on horseback, treed with the aid of trained hounds, and immobilized with an intramuscular injection of ketamine hydrochloride and xylazine hydrochloride (Hemker et al. 1984). Each immobilized cougar was fitted with a collar containing a motion-sensitive radio transmitter (Telonics, Inc., Mesa, Arizona). Radio-collared cougars were monitored with portable radio telemetry equipment on the ground and from the air. All radiolocations were assigned UTM coordinates and recorded to the nearest 100 m. An attempt was made to locate all radio-collared cougars a minimum of once each week.

The Boulder-Escalante study area, including areas occupied by collared cougars, was searched periodically for sign of new cougars (e.g., tracks, scats, scratches). When detected, uncollared cougars taking up residence and transients were captured and radio-collared.

### Road Track Surveys

Cougar density was measured as both the number of known cougars per km<sup>2</sup> in the survey area and the number of home ranges of independent cougars overlapping the survey road. We conducted both systematic (Fitzhugh and Smallwood 1985) and random-systematic (Van Dyke et al. 1986) road track surveys. Only dirt roads were surveyed.

For the systematic survey the study area was divided into three survey areas spatially and behaviorally (home range boundaries) isolated from the others. One 11.3-km section of road was chosen in each area; roads were similar in elevation change, habitat type, and condition

(substrate, surface condition). Survey areas differed in density (independent adult cougars per km<sup>2</sup>) and the number of home ranges that intersected road sections: 2-3 in the first, 4-5 in the second, and 6-7 in the third.

Roads were surveyed from a pickup truck at 8-12 kph. Each road including both shoulders was dragged with a conifer tree pulled from the rear of the truck. The following day both sides of the road were searched for cougar track sets by driving on one side and returning on the other. A track set was defined as a continuous set of tracks created by one cougar on a single occasion. Three to 10 days later each road was again surveyed and dragged. We felt that after 3 days the effect of dragging would be minimal, and movements of cougars in the area (Hemker et al. 1984) suggested this interval would be sufficient to provide independent sampling periods. Dust ratings, determined from imprint characteristics of the observer's shoe (Van Dyke et al. 1986), were conducted every km before and after dragging to quantify road surface condition. At each stop the observer took 10 steps, 5 on each shoulder; then each impression was given a point value from 1 to 4. Simple regression analyses were used to examine the relationship between track sets per km surveyed and both measures of density. Track sets per km surveyed were considered the independent variable because only these data would be available to the manager.

The random-systematic road track survey involved dividing the study area into four survey areas. Again, the four areas were spatially and behaviorally isolated from each other. Two survey areas had 2-4 cougar home ranges overlapping roads and two had 5-7. Each area had a different density of cougars (0.017, 0.032, 0.042, 0.057 cougars/km<sup>2</sup>). A 16-km stretch of road was randomly selected in each area, and the first area to be surveyed was randomly chosen. Surveys were run as described for systematic surveys except that an all-terrain vehicle was used and only one shoulder of the road was dragged. Once all four areas had been surveyed, we returned to the first area, randomly selected different 16-km survey routes for each area and began the sequence again. Surveyed roads were not eligible for resampling until all dirt roads within an area had been sampled once. For analyses, each 16-km section of road was divided into segments varying in length from 1 to 10 km depending on the number of home

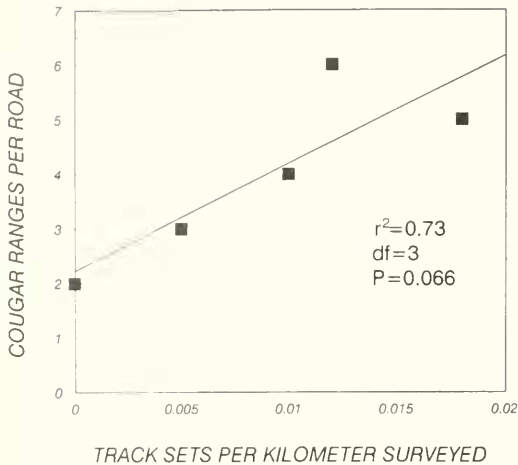


Fig. 1. Relationship between cougar track sets per kilometer and cougars with home ranges overlapping the survey road on the Boulder-Escalante study area, Utah, 1988.

ranges overlapping the segment. Each segment then had a home range overlap value (2–7) and was assigned one of the four density values.

We examined the relationship between track sets found per km surveyed and the two measures of density with simple regression analysis. Road segments with the same home range overlap values were combined to obtain km surveyed, as were road segments representing the same densities. Data points entered into the regression equations were the sum of tracks found in each of the six home range overlap or four density categories divided by the sum of km surveyed in the respective categories.

We evaluated whether dragging would improve survey roads with a simple regression of pre-drag dust ratings against post-drag ratings. Data from both road track surveys were combined to increase sample size, and regression slopes were tested against 1. The number of track sets found on dragged and undragged roads was also compared by dividing the total number of track sets in each by the total km searched in each.

Multiple regression analysis was used to examine the effect of rainfall and traffic on one-day, post-drag dust ratings. Pre-drag dust ratings, rainfall, and traffic were the independent variables considered. We used two indicator variables to code the three levels of rainfall and two to code the three levels of traffic. The three road surface categories related to increasing rainfall intensity were: unchanged, dimpled (individual raindrop impressions distinct), and

deformed. Traffic categories were: no traffic, traffic on one-half the length of the road, and traffic on more than one-half the length.

## RESULTS

The systematic road track surveys were conducted May–June 1988. During this period 407 km of road was surveyed and two track sets were found. One-hundred thirty-five km (12 surveys) of road was surveyed in an area where 2–3 ranges overlapped the survey road, 146 km (13 surveys) where 4–5 ranges overlapped, and 126 km (11 surveys) where 6–7 ranges overlapped the survey road. Unequal survey numbers resulted from weather or equipment problems precluding surveys being run. Each road (11.3 km) was surveyed in three hours, with two areas being surveyed the first day and the third the next day. The two track sets were found on a road overlapped by 4–5 cougar home ranges. Because of the small number of track sets found, these results were not regressed against either measure of density.

Random-systematic road track surveys were run in July and August 1988. During this period 684 km was surveyed and seven cougar track sets were found. Three hundred fifty km (37 road segments) was located in an area of low-home-range/road overlap and 334 km (42 road segments) in high. The number of km searched per day was 16.

We identified no relationship between density, as measured in cougars per km<sup>2</sup>, and track finding frequency ( $r^2 = .00$ ,  $P = .586$ ,  $n = 4$ ). However, the relationship ( $Y = 2.23 + 197X$ ,  $r^2 = .73$ ,  $P = .066$ ,  $ROOT\ MSE = 1$ ,  $n = 5$ ) between number of cougars known to have home ranges overlapping the road and track-finding frequency was positive (Fig. 1). The data point associated with the home range overlap value of 7 was dropped because <20 km of road was surveyed. Results from both one-day periods and three or more days were combined for these analyses.

Because of the small number of track sets found, we did not statistically evaluate the relationship between track-finding frequency and dust rating categories or dragged and undragged roads. We found a positive relationship between post-drag dust ratings ( $Y$ ) and pre-drag ratings after one ( $X1$ ) and three or more ( $X2$ ) days ( $r^2 = .54$ ,  $Y = 6.05 + 0.875X1$ ,  $P < .001$ ,  $ROOT\ MSE = 10.4$ ,  $n = 43$ ) ( $r^2 = .34$ ,  $Y = 3.14 + 0.707X2$ ,  $P < .01$ ,  $ROOT\ MSE = 4.6$ ,  $n = 20$ ). However, we failed to reject the null

hypothesis (slope = 1) in both cases, indicating that our method of road dragging did little to improve tracking medium or that dust ratings were not sensitive enough to detect changes in the tracking medium. Data associated with heavy rainfall were omitted from these analyses. Multiple regression analysis (one day) relating post-drag dust ratings to pre-drag dust ratings, rainfall, and traffic yielded a three-variable model that contained only pre-drag dust ratings ( $X_1$ ) and rainfall ( $X_2$ ,  $X_3$ ) as the independent variables ( $r^2 = .67$ ,  $Y = 7.65 + 0.835X_1 + 0.76X_2 - 5.65X_3$ ,  $P < .000[X_1]$ ,  $P < .583[X_2]$ ,  $P < .001[X_3]$ ,  $ROOT\ MSE = 9$ ,  $n = 43$ ). Moderate rainfall had little effect on post-drag dust ratings. However, heavy rainfall resulting in road surface deformity had a deleterious effect on post-drag dust ratings. The effect of traffic on post-drag dust ratings was not significant ( $P > .05$ ).

#### DISCUSSION

The utility of road track surveys for monitoring cougar abundance is limited by the generally poor relationship between cougar density and track-finding frequency. Both our results ( $r^2 = .00$ ), although based on a small sample, and those of Van Dyke et al. (1986) ( $r^2 = .15$ ) indicate a weak relationship between cougar density and track-finding frequency. The strongest significant relationship found by Van Dyke et al. ( $r^2 = .61$ ) resulted from a multiple regression model with track-finding frequency the dependent variable and female density, good tracking conditions, and proximity of cougars to survey road the independent variables. As the authors noted, however, a biologist would seldom have knowledge of cougar distribution in regard to survey roads.

The poor relationship documented between track-finding frequency and cougar density appears the result of sampling problems, largely beyond the control of the biologist. Cougars are rarely uniformly distributed (Henker et al. 1984), and available roads, the sampling strata, are seldom abundant enough or optimally located to sample from a nonuniform distribution. Available roads, for example, could fail to intercept any cougar home ranges or could be found only in the areas occupied by cougars. In both scenarios, the index (tracks found) could easily prove to be a poor measure of change in cougar numbers over time in an area. Likewise, because of the potential importance of road

location in determining number of tracks found, use of index values to compare cougar density between areas in tennons. The probability of existing road networks in two areas sampling similarly from the two populations seems small. Use of track surveys to document cougar presence is feasible, but again, the approach ultimately relies on roads intersecting a cougar home range.

Ideally, roads with suitable tracking surface should be abundant, as in parts of the Northwest where logging is common, and located so that the home range of each cougar would be intercepted. Even in an ideal situation, however, the index may prove sensitive only to relatively large changes in cougar population size. Twenty-seven percent of the variance in number of tracks found was unexplained by number of cougar home ranges overlapping survey roads.

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